Seasonal Occurrence of the Pelagic Copepoda in Mississippi Sound

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ABSTRACT

Collections of planktonic copepods from Mississippi Sound were made from January 1965 to March 1966. The following fifteen free-living copepods were identified: *Eucalanus pileatus, Paracalanus parvus, Centropages hamatus, Centropages furcatus, Temora stylifera, Temora longicornis, Labidocera aestiva, Labidocera* species, *Acartia tonsa, Oithona brevicornis, Oithona* species, *Oncaea venusta, Corycaeus species, Sappharina nigromaculata* and *Euterpina acutifrons.*

It was found that there is a definite seasonal distribution of copepods in Mississippi Sound with peak populations of copepods occurring in the spring, summer and fall.

INTRODUCTION

The copepods have a vital role in the economy of the sea. Clarke (1957) referred to them as "key industry animals," thus indicating that they act to convert the phytoplankton into a form of food available to larger animals in the environment that are not able to feed directly on the phytoplankton. Knowledge of the abundance and seasonal occurrence of the copepods is of fundamental importance.

The literature published on copepods of the Gulf of Mexico is sparse. Herrick (1887) published a list of a number of copepods collected from the northern Gulf Coast. His investigations extended from the west coast of Florida to the Gulf Coast of Alabama. Foster (1904) reported on the copepods collected from the area around the Gulf Biologic Station in Louisiana. King (1949) published a list of species taken in a ten-month survey of the west coast of Florida. Davis (1949) also published a composite and updated list of the copepods collected from a number of stations located on both the east and west coasts of Florida, which included both marine and brackish water forms. Jones (1952) conducted a preliminary survey of copepods from the Florida Current. His work included notes on the seasonal distribution and vertical distribution of the copepods in that region. Owre (1962) compiled a composite list of 129 species of copepods which were found in the Florida Current. This list was amended by Owre and Foyo (1964) and 45 species were added to the original list, making a total of 174 species of copepods identified from the Florida Current. Owre and Foyo (1967) published an illustrated key to the copepods found in the Florida Current. Schmidt (1954) reviewed all studies of copepods of the Gulf of Mexico and estimated "that close to a hundred free-swimming copepods, representative of some 70 genera, have to date been taken in the Gulf of Mexico and brackish waters adjacent thereto." Grice (1956) conducted a qualitative and quantitative seasonal study of the copepods of Alligator Harbor, Florida. Fleminger (1957) and Grice (1960) reported on various specific genera and added several new species to the ever growing list of species found in the Gulf of Mexico. Gonzalez (1957) reported on the seasonal distribution of the copepods of the Mississippi Delta region. Hopkins (1966) listed several copepods taken in the St. Andrew Bay System, Florida, with notes on their seasonal occurrence there. Woodmansee (1958) reported on a study of the seasonal distribution of the zooplankton off Chicken Key in Biscayne Bay, Florida, and Richmond (1962) listed one species of copepod collected near the beach of Horn Island in the Mississippi Sound.

The purposes of this investigation were to determine: (1) the quantitatively important species of copepods in the Mississippi Sound region of the Northern Gulf of Mexico; and (2) the relative abundance of each species through the course of a year.

DESCRIPTION OF THE MISSISSIPPI SOUND

According to Moore (1961), Mississippi Sound is an elongated body of water partially enclosed by a series of barrier islands. The Sound is approximately eighty miles long by ten miles wide, with an average depth of about ten feet (Figure 1). The axis of the sound is almost due east and west. The eastern boundary is the eastern end of Dauphin Island, near the lower end of Mobile Bay, and the western end terminates at Grand Island, Louisiana. Moore (1961) stated that the bottom is mud, but this is replaced by sand close to the barrier islands and in some places along the mainland. The eastern one-third of the Mississippi Sound lies in Alabama.

The major fresh water entry into Mississippi Sound is the Pascagoula River which empties into the Sound near the Alabama-Mississippi border, and the Pearl River which flows into the Sound about four miles west of Grand Island. In addition to these two rivers, fresh water flows into the Sound through Biloxi Bay and the Bay of St. Louis. Biloxi Bay is supplied with fresh water by the Biloxi River, the Tchouticabouffa River, Old Fort Bayou and Bernard Bayou. The Bay of St. Louis is supplied by the Jourdan and Wolf Rivers.

MATERIALS AND METHODS

Field Procedure

Once each month through the period January 1965 to March 1966, zooplankton collections were made at 10:00 A. M. All of these collections were made at a station located in Mississippi Sound, lying in Latitude 30° 17' N. and Longitude 88° 45' W. (Figure 1).

Each collection was made by towing a Clarke-Bumpus quantitative plankton sampler (Clarke and Bumpus 1940 and 1950) four times

Figure 1. Diagram of Mississippi Sound indicating the collecting station (X).

in the immediate areas of the station. The tows were made at the surface, one with the sampler equipped with a No. 10 net, which has 109 meshes per linear inch, and one with the sampler equipped with a No. 2 net, which has 54 meshes per linear inch. This same procedure was repeated at a depth of 11 feet. All tows were made for a period of 15 minutes each. The resulting catch was preserved in 10 per cent formalin solution in sea water which had been buffered with borax.

Laboratory Procedure

Samples were then brought into the laboratory for analysis. The counting procedure involved the enumeration of only the sixth copepodid stage. Preliminary to the quantitative counts, the volumes of the zooplankton samples were adjusted to 30 ml. The large amount of plankton collected on November 25, 1965, made it desirable for counting to adjust the volume to 100 ml by the addition of filtered sea water. A pipette with a 5 mm aperture was used in extracting a one-third aliquot portion from each concentrated zooplankton sample. This was placed in a syracuse watch glass for counting. The total number of sixth stage copepodids were then counted. All counts were made using a magnification of 60X with a binocular dissecting microscope.

The four monthly samples were counted separately, added and averaged, thus giving a mean for the collecting data. This number may not be representative of abundance for the month in which the sample was taken because the sample represents but one day of the month. The copepod population could vary greatly at other times during the month due to such factors as available food supply, temperature, salinity and dissolved oxygen. The number of sixth stage copepods are given in Figure 2 and Table 2 and are expressed as numbers per m^3.

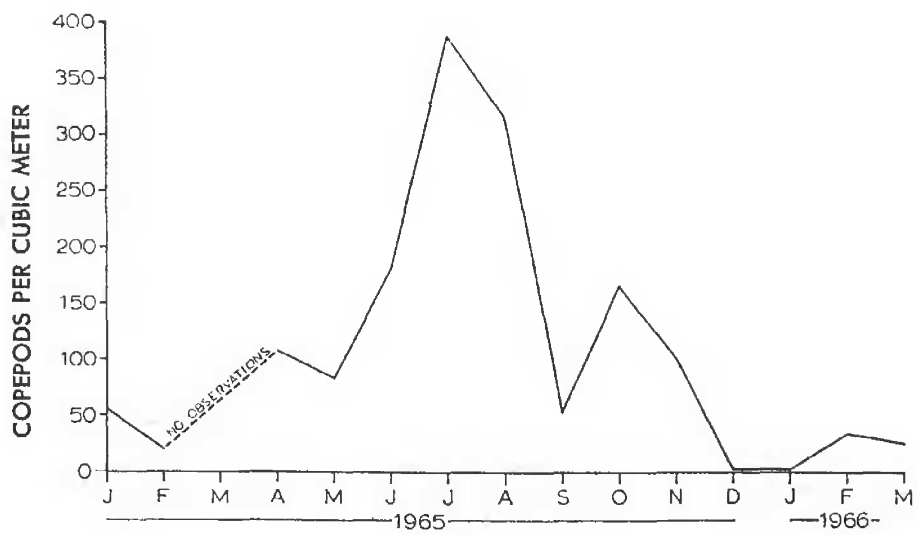

Figure 2. Average number of adult copepods per cubic meter by months. Dashed line indicates no observations.

DISCUSSION OF BIOLOGICAL DATA

The Total Copepod Population

Fifteen free-living copepods were identified in the plankton samples. Twelve were identified to species and three only to genus. Nine of these belong to the Order Calanoida, five to the Order Cyclopoida and one to the Order Harpacticoida. The Order Calanoida contained the greatest number of individuals with 81 per cent of all copepods collected in Mississippi Sound (Table 1). The cyclopoids ranked second in abundance and collectively accounted for 14 per cent of the total number of copepods. Although one species occurred quite frequently, individuals of the Order Harpacticoida were rare and comprised but 5 per cent of all copepods.

The monthly distribution of the entire copepod population at the collecting station in Mississippi Sound is given in Figure 2. Three modes of abundance of copepods are apparent—a small one in April 1965, the maximum in July and August 1965, and a minimum peak in October 1965. The first maximum followed a phytoplankton "bloom" which occurred in the second week of April. This phytoplankton "bloom" was apparently the result of a thorough mixing of the Sound by high winds during March and the first week of April. According to Clarke (1957) this mixing brings back into the surface waters the "vital" nutrients which are necessary for both plant and animal life.

The July-August maximum contained the greatest number of species found during the sampling period. Grice (1956) and Woodmansee (1958) also found that the greatest numbers of copepods occurred in the summer. The total copepod population dropped off in early September. This decrease in the copepod population at this

TABLE 1

Relative percentages of the three orders of free-living copepods found in the Mississippi Sound.

ORDER	PERCENTAGE
Calanoida	81.0
Cyclopoida	14.0
Harpacticoida	5.0

time may have been due to an overcrowding effect caused by the large number of zooplankton which used up the available food supply. The fall copepod maximum occurred in October (Figure 2 and Table 2) following a large phytoplankton "bloom" in September. During October only the two surface tows were completed, thus the total number of copepods present at that time may have been greater or smaller than is shown in Figure 2 and Table 2.

A gradual decrease in the number of copepods was noted through December with minimum numbers occurring in the January, 1966, sample. Grice (1956) and Woodmansee (1958) also found that the copepod population was lower during the winter.

The minimum numbers of copepods per m^3 collected in January 1966, may be attributed to the extremely low temperature of 4.2°C recorded for the January 1966 sampling date. Following the January minimum the monthly catches increased. The February and March 1966 samples contained an abundance of ctenophores (*Mnemiopsis* sp.). These organisms were also present in the spring months of 1965, and may have been responsible for small numbers of copepods since they are active carnivores and may have been feeding on the copepod stock. According to Bigelow (1924) the ctenophores (*Pleurobranchia* and *Beroe*) are known to feed on small copepods and other small crustaceans. In addition, during the month of May 1965, there was an abundance of other zooplankters not frequently observed in the preceding four months. Immature stages of the following groups of animals were noted: Annelida, Cirripedia, decapods, Echinodermata and Tunicata. These larval forms could have a definite effect on the copepod population since they are in direct competition with copepods for food. Larval fish and arrow worms were also numerous. These organisms feed extensively on copepods and other small crustaceans according to Bigelow (1924) who stated, "It is probable that the comparative scarcity of copepods, often remarked at the precise levels, localities, or times when *Sagitta* abound, is direct evidence of the extent to which the latter may reduce the stock of their prey."

In summary, the competition and predatory habits of arrow worms, small fishes, and possibly ctenophores may be responsible for the smaller copepod populations found during the spring of 1965

LIST OF SPECIES

CALANOIDA

Family Calanidae

Genus *Eucalanus* Dana

Eucalanus pileatus Giesbrecht

Family Paracalanidae

Genus *Paracalanus* Boeck

Paracalanus parvus (Claus)

Family Centropagidae

Genus *Centropages* Krøyer

Centropages furcatus (Dana)

Centropages hamatus (Lillijeborg)

Family Temoridae

Genus *Temora* Baird

Temora stylifera (Dana)

Temora longicornis (Muller)

Family Pontellidae

Genus *Labidocera* Lubbock

Labidocera aestiva Wheeler

Labidocera species

Family Acartiidae

Genus *Acartia* Dana

Acartia tonsa Dana

CYCLOPOIDA

Family Oithonidae

Genus *Oithona* Baird

Oithona brevicornis Giesbrecht

Oithona species

Family Oncaeidae

Genus *Oncaea* Phillippi

Oncaea venusta Philippi

Family Corycaeidae

Genus *Corycaeus* Dana

Corycaeus species

Genus *Sappharina* Thompson

Sappharina nigromaculata Claus

TABLE 2

Table showing total number of adult copepods counted, cubic meters of water filtered and average number of copepods per cubic meter of water.

DATE	TOTAL NUMBER OF COPEPODS	M^3 OF WATER FILTERED	COPEPODS/M^3
Jan.	729	13	56
Feb.	843	43	20
March			
April	2,968	28	106
May	1,922	23	83
June	4,110	23	178
July	11,940	31	385
Aug.	7,555	24	314
Sept.	1,155	22	53
Oct.	1,812	11	165
Nov.	3,783	38	100
Dec.	123	51	2
Jan.	4		
Feb.	467	14	33
March	858	34	25

HARPACTICOIDA

Family Tachydiidae

Genus *Euterpina* Norman

Euterpina acutifrons Dana

SYSTEMATIC ACCOUNT OF THE SPECIES

Family Calanidae

Genus *Eucalanus* Dana

Eucalanus pileatus Giesbrecht

Eucalanus pileatus was essentially a member of the summer fauna although it was found in February and November of 1965 in reduced numbers (Table 3). The maximum number of *E. pileatus* occurred in August, 1965, and the minimum number occurred in February, 1965.

TABLE 3

Monthly occurrence of copepods collected in the Mississippi Sound.

	Eucalanus pileatus	Paracalanus parvus	Centropages hamatus	Centropages furcatus	Temora stylifera	Temora longicornis	Labidocera aestiva	Labidocera species	Acartia tonsa	Oithona brevicornis	Oithona species	Oncaea venusta	Corycaeus species	Sappharina nigromaculata	Euterpina acutifrons
Jan. '65								360	369						
Feb.	3*							**504**	329		1*			3*	3*
March															
April		**1,110**					46		897	**915**					
May		994					30		3*	895					
June	585	189		570		3*	282		165	543		15*	321		**1,437**
July	815	534		315		140	**8,856**	15	72	825	**24**	**270**	26		48
Aug.	**2,142**			**1,143**	**57**	**2,310**	876		23	198		69	**678**	**6**	48
Sept.	6	69		30		180	261	195	258	147			3		6
Oct.		174		3*		15	24	186	1,287	123					
Nov.	9	279	**327**	27		138	3*	3*	**3,409**	324					264
Dec.			42	9					63	3*					6
Jan. '66									4						
Feb.			3*						465						
March		27*		10		19		171	538	93					

Bold face numerals — maximum. * — minimum.

Family Paracalanidae

Genus *Paracalanus* Boeck

Paracalanus parvus (Claus)

Paracalanus parvus was found from April through December, 1965. It was not recorded again until March 1966 (Table 3). *P. parvus* reached a peak population in April 1965, and then decreased in numbers to reach a minimum in September 1965.

Family Centropagidae

Genus *Centropages* Krøyer

Centropages hamatus (Lilljeborg)

This calanoid copepod was one of the characteristic members of the copepod population during the winter (Table 3). It was found in November and December 1965, and again in February 1966. An unusually low temperature of 4.2°C recorded for January 1966 may have been responsible for its absence in January.

Centropages furcatus (Dana)

During the period of this investigation *Centropages furcatus* was taken from June 1965 through December 1965 (Table 3). It then disappeared and was not taken again until March 1966. The low temperatures recorded in the winter accounts for the absence of *C. furcatus* through the winter.

Family Temoridae

Genus *Temora* Baird

Temora stylifera (Dana)

Temora stylifera was only collected in August, 1965 (Table 3). It only accounted for about 1% of the total August copepod population. It is suspected that this species occurs more frequently outside the barrier islands.

Temora longicornis (Muller)

Temora longicornis is a member of the spring and summer copepod population found in the Mississippi Sound (Table 3). It was found from June 1965 to November 1965. It disappeared in December and was not recorded again until March 1966.

Family Pontellidae

Genus *Labidocera* Lubbock

Labidocera aestiva Wheeler

Labidocera aestiva was one of the largest copepods collected in the Mississippi Sound. Numerically, this calanoid copepod formed about 74% of the total copepod population found in July 1965.

This calanoid was collected from April 1965 to November 1965 (Table 3). Fleminger (1956) found *L. aestiva* to be the most abundant species of Pontellidae in the Gulf of Mexico. He found that this calanoid was confined almost exclusively to the northern neritic waters of the Gulf between Florida and Laguna Madre, Texas. Numerically, this species was highly concentrated between Apalachicola Bay, Florida, and the east Texas coast. This could account for the fact that in this study *L. aestiva* was the dominant copepod in July.

Labidocera species

Labidocera sp. occurred sporadically throughout the sampling period (Table 3). It reached a maximum in February 1965, disappeared in the spring and was found again in the late summer and fall, then was not found again until March 1966. At no time during the 15 month sampling period did it account for any significant portion of the total copepod population.

Family Acartiidae

Genus *Acartia* Dana

Acartia tonsa Dana

Acartia tonsa was one of the characteristic members of the copepod population in Mississippi Sound, individuals of this species being taken the year around (Table 3). It was the second most abundant species.

Catches of *A. tonsa* during the winter months were generally higher than in the summer months. In May, *A. tonsa,* like most other year round species, exhibited a marked numerical decrease, apparently as a result of predation. During the summer months, *A. tonsa* was found only in small numbers. This species reached maximum concentrations in November 1965.

Family Oithonidae

Genus *Oithona* Baird

Oithona brevicornis Giesbrecht

Oithona brevicornis was the most abundant cyclopoid taken during this study. It was found from April 1965 through December 1966 (Table 3). By January 1966, it had disappeared but was found again in March of that year.

The maximum number of *O. brevicornis* occurred in the spring of 1965. From June until December, the numbers steadily decreased until January, when they were completely missing from the total copepod population.

Oithona species

In February 1965 and in July 1965 a copepod was collected which identified only to genus (Table 3). It very closely resembled *Oithona similis,* but there was only one adult individual collected in February and one adult collected in July. It was felt that this was insufficient material to make a positive identification and thus name a new species for this area, although it is possible that *O. similis* could occur in this region.

Family Oncaeidae

Genus *Oncaea* Philippi

Oncaea venusta Philippi

Oncaea venusta was a member of the summer fauna of Mississippi Sound. It was only found in June, July and August (Table 3). At no time did *O. venusta* account for any significant portion of the total copepod population.

Family Corycaeidae

Genus *Corycaeus* Dana

Corycaeus species

Corycaeus sp. was essentially a member of the summer fauna (Table 3). It was found consistently from June through September. Three individuals were found in February 1965 sample and it is possible that these were strays which came in from the waters outside the barrier islands.

Genus *Sappharina* Thompson

Sappharina nigromaculata Claus

Sappharina nigromaculata was recorded in the August sample, when six individuals were taken (Table 3). It is thought that this cyclopoid was also a stray from the waters outside the barrier islands. A. G. Fish states that *S. nigromaculata* occurs in large numbers outside the barrier islands in the Gulf of Mexico (personal communication with A. G. Fish).

Family Tachydiiae

Genus *Euterpina* Norman

Euterpina acutifrons Dana

This was the only species of harpacticoid copepods encountered during this investigation. It was found sporadically during the winter, summer and fall of 1965 (Table 3). This harpacticoid reached a maximum concentration in June. From June through the summer it steadily decreased in numbers until it completely disappeared in January, 1966. After that time, *E. acutifrons* was not encountered again.

Grice (1956) found *E. acutifrons* to be a year around member of the copepod population of Alligator Harbor. He found that the maximum numbers of *E. acutifrons* occurred during the spring and summer.

Each month that this species was collected ovigerous females were found, indicating that possibly *E. acutifrons* breed the year around in the Mississippi Sound.

Sutcliffe (1950) found *E. acutifrons* during most of the year, but it was present "in greatest numbers at higher temperatures" at Beaufort, N. C. Davis (1949) recorded it as the most common harpacticoid copepod in the collections he examined from the Florida coasts, while King (1949) reported it from many localities along the west coast of Florida.

SUMMARY

Monthly quantitative zooplankton collections were made in Mississippi Sound from January 1965 to March 1966.

Thirteen species of copepods were assigned to eleven genera. The numerical abundance and seasonal occurrence of all species were traced and these findings were compared when possible with similar studies on the west coast of Florida. Only one species, *Acartia tonsa,* occurred the year around.

The greatest number of copepods occurred in summer and the smallest in winter. The average number over the entire period of study was approximately 115 copepods per m^3.

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